

# JSC : A JavaScript Object System

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## Abstract

The JSC language is a superset of JavaScript designed to ease the development of large web applications. This language extends JavaScript's own object system by isolating code in a class declaration, simplifying multiple inheritance and using method implementation agreements.

## 1 Motivation

As web applications have been gaining more dynamic behavior, JavaScript has become more important in web development. As such, it is useful to use a software engineering approach to JavaScript.

JavaScript object-oriented model is prototype-based. This model can be extremely versatile to develop. However, in a large team of developers, not only problems such as name collisions and unintentional method redefinition can occur, but also maintenance becomes an issue.

JSC attempts to remedy some of these issues by implementing a Object System on top of standard JavaScript.

## 2 Related Work

There have been some attempts to add structured programming to JavaScript.

In ECMAScript (language from which JavaScript is a dialect) last version were added support for defining classes. Another dialect of ECMAScript, ActionScript supports defining classes. Although those systems are more advanced (they support typechecking via annotation on variables, generics, dynamic classes, templates, etc.), they aren't available in the current browsers. It's expected that future versions of JavaScript extend this behavior from ECMAScript.

Other attempts have been creating supersets to JavaScript. One example of this is Objective-J. This is a strict superset of JavaScript, but adds an object system by implementing a language similar to Objective-C. This approach is similar to JSC, but this language uses the same message passing than Objective-C making the methods unparsable by JavaScript.

### 3 Object Oriented JavaScript

In JavaScript, a class is a function, so its definition is similar to the definition of a function, as shown next:

```
1 function Rectangle(w, h) {  
2     this.width = w;  
3     this.height = h;  
4 }
```

A function in javascript is of type `Function` but behaves similarly to a hash or a dictionary. One of the properties in this object is the **prototype**. This property represents a structure that is not yet fully defined and it is only formed when it is instantiated. Instantiation can be done by:

```
new Rectangle(10,10);
```

`new` operator will invoke the function `Rectangle` with `this` as a new object with a reference to `Rectangle.prototype`, and return this object<sup>1</sup>. Any changes made to this object will only affect the new object, and not the prototype. If a property is not defined in the object but on the prototype, then the prototype's value is returned.

A method can be defined by adding a function to the class prototype as shown next:

```
1 Rectangle.prototype.getArea = function () {  
2     return this.height * this.width;  
3 }
```

Methods are called like this:

```
rectangle.getHeight()
```

As with the constructor, `getHeight` will be invoked with `this` as a reference to the instance, in this case to `rectangle`. This method will be available to all instances that don't define locally the method `getArea`.

The code below shows how inheritance is implemented: by copying the **prototype** of the superclass to the subclass.

```
1 function PositionedRectangle(x, y, w, h) {  
2     Rectangle.call(this, w, h);  
3  
4     this.x = x;  
5     this.y = y;  
6 }  
7 PositionedRectangle.prototype = new Rectangle();
```

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<sup>1</sup>Actually `Rectangle` could return anything, but the default is `this`

### 3.1 Problems

The first problem is the inexistence of separation between functional and object oriented programming. All the examples shown are extensions to JavaScript's functional programming that allows to create a behavior similar to object oriented.

Another problem is that today browsers share the same environment with all JavaScript files. It's possible to have the same method defined in two distinct files. This can difficult debugging and maintenance.

## 4 Objectives

JSC is an extension to JavaScript and was developed with the following goals in mind:

- Create a new object-oriented language, but keep (as much as possible) JavaScript's syntax and semantics.
- Provide mechanisms to maintain the code isolated in packages.
- Provide a meta-object protocol that allows an easy use of reflection and intersection, while keeping the code organized.
- Provide simple and easy to use multiple inheritance.
- Provide an implementation agreement between classes, which is similar to Java's interfaces or to Objective-C's protocols.

## 5 JSC

### 5.1 Class Definition

JSC is defined in classes. Each class is defined in a single file. A simple JSC Class is shown next:

```
1 package UI.Component;
2
3 class Rectangle{
4   slots:[height,width],
5   Rectangle: function (w,h){
6     this.setHeight(h);
7     this.setWidth(w);
8   },
9   getArea: function (){
10    return this.getHeight() * this.getWidth();
11  }
12 }
```

Each class begins with a package declaration. A class is always referred to by its package and class name (in this case `UI.Component.Rectangle`). The body of the class is declared as a JavaScript `Object`. The fourth line represents

the slot declaration. In JSC, class slots can't be directly used. To access a slot, a getter and setter method is provided for each slot. The fifth and ninth lines declare a constructor and a method, respectively. A constructor is a method with the same name of the class. A constructor is not required, but there can be only one by class.

It is important to notice that only the class header and the slot definition aren't capable of being parsed by JavaScript.

## 5.2 Instantiation

JSC attempts to minimize the usage of the global environment. Actually, the only global definition required is the function `Class`. This function expects a string with the canonical class location (package and name), and returns the meta-object representing such class. In our example, `Rectangle`'s meta-class can be obtained by:

```
Class("UI.Component.Rectangle")
```

In runtime, each meta-class contains, among others, a method called `create`. This method will create a new instance and call the class constructor. With this, we can now instantiate our `Rectangle` class:

```
Class("UI.Component.Rectangle").create(10,10)
```

## 5.3 Inheritance

Inheritance can be used by extending the superclass as shown next:

```
1 package UI.Component;
2
3 class PositionedRectangle extends UI.Component.Rectangle{
4   slots:[x,y],
5   PositionedRectangle: function (x,y,w,h){
6     Class("UI.Component.Rectangle").init(this,w,h);
7
8     this.setX(x);
9     this.setY(y);
10  }
11 }
```

Inheritance in JSC works like *mixins*. Each class method and slot from the superclass will be added to the subclass. A class can extend from several classes. In `PositionedRectangle` both the height and width slot, getters and setters from `Rectangle` were copied. The token `extends` instead of `mixin` was used because it makes the class header similar to ECMAScript V4 and Java's.

Each meta-class object contains an `init` method that calls the constructor for that class, using the first argument as the instance. This is similar to how Python's superclass constructor is called.

## 5.4 Static Enviroment

Each JSC class can declare methods that can be used on a meta-class level. A simple example is shown next:

```
1 package Main;
2
3 class App {
4   static:{
5     main: function (args){
6       ...
7     }
8   }
9 }
```

## 5.5 Protocols

A protocol in JSC assures the existence of certain methods. A protocol declaration is shown next:

```
1 package UI.Component;
2
3 protocol Draggable {
4   element: true,
5   eventListener: false
6 }
```

In our example **Draggable** declares the existence of two methods, **element** and **eventListener**. The keyword next to the method name declares the need to implement it. **true** declares that this method is required to be implemented in each class that extends this protocol while **false** guarantees that if such method is not implemented, an empty function with such name will be provided.

A protocol can be extended only from other protocols, and a class can implement any number of protocols. The verification of required methods is done both in run- and compile-time.

## 5.6 Class initialization

When JSC starts<sup>2</sup>, all classes in the classpool are going to be initialized. This is done by invoking the meta-class method **classInit**.

This method will compute the effective set of methods and slots that this class possesses, and it will detect if all the protocols have been satisfied. Finally, it will setup the prototype.

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<sup>2</sup>See Usage for more details

## 5.7 Runtime intersection

It is possible to create a new class/protocol, or change a class/protocol by altering the meta-class definition, in any moment during execution. However, it is required to call again `classInit` so that the prototype is reconstructed.

It's also possible to extend the behavior of JSC by extending the `lang.Class` class. Protocols is one example of this, but it's quite simple to implement something similar to java's abstract classes in JSC.

## 6 Current Problems

### 6.1 Global Variables

JSC attempts to minimize the usage of the global environment by encapsulating the code into classes. However, JavaScript allows the declaration of global variables from within a function.. Any variable that is declared without the keyword `var` is declared in the global environment. For instance:

```
1 function Foo(){
2   var local = 1;
3   global = 1;
4 }
```

Currently, this is not allowed in JSC, but it is not verified.

### 6.2 Slot default value

Currently, the slot declaration doesn't allow a slot to have a default value. It would be nice to have a slot declaration similar to this:

```
1 package Bar;
2
3 class Foo{
4   slots:{
5     aSlot:{ getter:"getSlot", setter:"setIt", default:1 },
6     anotherSlot: { default: Class("Baz.Bing").create(1,2) }
7   }
8 }
```

Currently, JSC doesn't support this syntax because there isn't a easy to use parser of JavaScript available. The JSC compiler assures the correctness of the code by loading the methods into a JavaScript Engine and detecting the parsing errors generated.<sup>3</sup>

When such parser is available, both this and the Global Variables problem can be addressed.

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<sup>3</sup>`jssc` (JSC Compiler) currently uses Google's V8 Engine

## 7 Usage

The current compiler can target 3 usage methods:

- **Server** - JSC was developed due to a need for developing a lot of code to run in a web server. In this mode, the code is loaded into a RDBMS and loaded upon need.
- **Client** - Another usage is generating a single classpool image in a self contained JavaScript file and load it in a browser like an ordinary JavaScript file. The JSC code can be accessed from other JavaScript files by using `Class` function.
- **JSC Virtual Machine** - `jscvm` is a small virtual machine implementation of JSC.

## 8 Performance

A small library, implemented in JSC and with 19 files, occupies 196 KB. After compilation targeting the browser ended with a single file occupying 56KB. This file takes from below a second in Chrome and up to 2 seconds in Firefox.

After using the YUI Compressor<sup>4</sup> this file shrunk to 40Kb. It almost loaded instantaneously both in Chrome and Firefox.

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<sup>4</sup>YUI Compressor is available at <http://developer.yahoo.com/yui/compressor/>. This application not only removes whitespaces, but also reduces the variable names.